REVIEW PAPER

Revitalizing a Transplantation Science Curriculum through Creative Technology Methods

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Abstract

Donor Alliance of Colorado and Wyoming revitalized their transplantation science curriculum by infusing creative technology into lesson planning and methodologies. The overarching goal of this revitalization was to deliver accurate content to students, their families, and the education community about how transplants work and who this life-saving science impacts. This article recounts the work of the curriculum team to align design and computational thinking frameworks with discovering the present affordances of their middle and high school stakeholders and ultimately bridge available resources into an engaging and interactive curriculum. The curriculum team constructed this bridge from educators' affordances to their effectivities to provide them with virtual avatars, surveys to reveal current knowledge, audio and video content to invite questions, and interactive augmented reality applications to delve deeply into the study of the human body. The transplantation science curriculum connects stakeholders with accurate information to change the trajectory of transplantation science from misconceptions to registration as an organ, eye, and tissue donor. This article is a vital step to fill a gap in the literature about using creative technology methods to enact critical pedagogy as transformative teaching and learning that embraces the imperative that we, in education, mirror society.

Keywords: creative methods in lesson planning, technological, pedagogical, and content knowledge (TPACK) framework, computational thinking, design thinking, virtual avatars, critical pedagogy, affordances, effectivities

Citation
Sharon Mistretta (2023), Revitalizing a Transplantation Science Curriculum through Creative Technology Methods. *AI, Computer Science and Robotics Technology* 2023(2), 1–22.

DOI
https://doi.org/10.5772/acrt.19

Published
5 May 2023

1. Introduction

This article recounts the collaboration of the Donor Alliance organization of Colorado and Wyoming (DACW) and the author of this article to develop a transplantation science middle and high school curriculum to foster the importance of organ, eye, and tissue donation. The overarching goal of this project is to deliver

accurate content to students, their families, and the education community about how transplants work and who this life-saving science impacts. The transplantation science curriculum depicts a triad of individuals to communicate the nuances of transplantation science. Kate Leto is a high school freshman with a congenital heart defect called left ventricle cardiomyopathy. She requires a heart transplant because this main chamber does not pump blood effectively and will eventually result in heart failure. Kate's science teacher, Kevin Williams, will enact the curriculum with his anatomy and physiology class. Diego Vidales is Kate's classmate whose mom was a registered organ, eye, and tissue donor at the time of her sudden death. This triad formed an impactful alliance with the donation and transplantation community to foster the transplantation science curriculum. DACW requested that incorrect and harmful terminology traditionally employed by journalists regarding the recovery and procurement of organs, eyes, and tissues be entirely avoided in this article to foster a renewed accuracy about this life-saving process.

A collection of laws protects students' privacy, such as the Family Education Rights Privacy Act (FERPA) [1], Children's Online Privacy and Protection Act (COPPA) [2], the Children's Internet Protection Act (CIPA) [3], and Health Insurance Portability and Accountability Act (HIPAA) [4] protect individuals' education and health records. The collection of legislations, however, does not apply to Kate Leto, Kevin Williams, or Diego Vidales. One could call them virtual avatars (VAs) whose pre-recorded script informs viewers about authentic examples of a teacher, donor family, and future recipient of a life-saving organ. They are aggregate representatives of the stakeholders of DACW to provide plausible examples of individuals who come together to save and heal lives through organ and tissue donation. The VAs employed in this new transplantation science curriculum are fictional characters who serve as anchors to instruct students, their families, and the education community about accurate, authentic, lifesaving impacts of organ, eye, and tissue donation. The decision to register as an organ donor begins with the realization that, in the event of death, we can provide clear directives to our families to offer our organs, eyes, and tissues to save and heal lives. The fictional characters Kate, Kevin, and Diego provide emotional scaffolding as VAs to help dispel the misconceptions about donation and transplantation held by students, parents, and the education community.

2. *The landscape of transplantation misinformation*

Those curious about organ, eye, and tissue donation without the benefit of an accurate transplantation science curriculum might visit the website Goodreads.com [5] to search for stories about organ donation. The resulting list searched on Goodreads.com by the author of this article resulted in 16 works of fiction about the topic. At the top of this list, with a score of 199 reflecting readers'

votes and rankings up to five stars, is *Pieces of Me* by Kizer [6]. The book's synopsis includes a gory word typically associated with horror movies. This article has redacted the term at the request of DACW. The synopsis employed the term to describe the emotion felt by the spirit of the fictional donor, Jessica, who is angry about dying and her parent's decision to donate her organs after her fatal car accident. Fiction writers, including author of *Pieces of Me* [6], who write about organ and tissue donors, transplant recipients, and their families, include words of gratitude to those they interviewed to develop their stories. However, Kizer admits to taking liberties to bend the truth and timeline of events for the sake of their narratives. The author shares, "I greatly accelerated the time it takes for a person to heal and recover from an organ transplant" [6, p. 287].

Several works of fiction play on the fears of donors and recipients to include the presence, thoughts, dreams, and feelings of the donor in the lived experiences of the recipient, such as Eagan (the donor) and Amelia (the recipient), in a work of fiction, *In Heartbeat*, by Ellsworth [7]. Dystopian novels in the science fiction genre, such as *Unwind* by Shusterman [8], propose that parents conceive children solely to distribute their organs.

Media headlines and Hollywood filmmakers contribute to a tsunami of misinformation about organ donation. The Associated Press [9] asserted that actress Anne Heche died twice on August 5, 2022, when a fiery car crash resulted in her hospitalization in Los Angeles, where she was "peacefully taken off of life support." A beautifully written Op-Ed piece by pulmonary and critical care physician Dr. Lamas [10] attempted to set the record straight. Dr. Lamas indicated a pervasive misunderstanding about what happens between the time physicians declare a patient as "brain-dead" and the time when the patient's heart stops beating, which is sometimes days later. Lamas [10] explained the procedure that sets the stage for organ donation parallels what happened to Anne Heche. The National Institutes of Health define brain death as "the irreversible loss of all brain functions [11]." Brain-dead patients continue to have a beating heart but can no longer breathe on their own to provide oxygen to their bodies without the support of a ventilator. It is important to note that the American Academy of Neurology indicates that brain death is an irreversible loss of all functions of the entire brain, and all 50 states adopted this determination with the federal Uniform Determination of Death Act supported by additional legislation at the state level [12]. Medical professionals continue to consider new medical advances to suggest updates to practices and legislation regarding the uniform determination of death [13]. When doctors took patients, like Buffalo Bills football safety Damar Hamlin off his ventilator in the hospital after receiving CPR on the field on January 5, 2023, his neurological functions sustained breathing by himself [14]. Anne Heche's brain was dead, but Damar Hamlin's was not. Anne Heche did not die twice, as Los Angeles newsgroup

KTLA 5 reported [15], so doctors could recover her organs. A federal mandate is in place to notify organ procurement organizations, such as DACW, to ensure that all families know about their opportunity to donate their loved one's organs. Medical professionals specifically trained to approach the family about organ donation are separate and distinct from the doctors and nurses who continue to care for their patient whose brain no longer functions to support life [16].

Hollywood scriptwriters lead viewers to believe that doctors and organ procurement organizations loom over brain-dead patients with knowledge about specific organ recipients in mind. Doctors caring for a patient have no prior knowledge of potential recipients of organs. Their sole focus is to treat their patients, like Anne Heche and Damar Hamlin. Organizations such as Donate Life Hollywood work with production companies, writers, producers, networks, and actors to bring authentic, accurate language to productions that include stories of organ procurement and donation [17]. Recently, the Donate Life Hollywood Inspire Awards recognized Fox Network's, The Resident, The Long and Winding Road episode [18] for their authentic portrayal of organ donation. However, the Internet Movie Database (IMDb) includes a gory term rather than "procured" in the synopsis of The Resident [18]. The language of organ donation must be changed to avoid using predatory words to instead foster the lifesaving and healing gift of an organ, eye, or tissue to grateful recipients. The VAs, Kate, Kevin, and Diego connect students with accurate information and authentic terminology to change the trajectory of transplantation science from misconceptions to registration as an organ, eye, and tissue donor.

3. Design thinking and the transplantation science curriculum

The official definition of design thinking offered by Julie Stanford and colleagues is "A human-centered process for identifying and solving problems that result in effective, innovative solutions [19]." The problem at hand is revitalizing the seventh to twelfth-grade transplantation science curriculum of the DACW organization to disseminate accurate information about human organ, eye, and tissue procurement, donation, and transplantation. The throughput of the revised curriculum seeks to inform educators, students, and their families utilizing methods that foster technologies and creative learning.

The present transplantation science curriculum centers predominantly on face-to-face learning in Colorado and Wyoming classrooms. The education division of DACW currently delivers the lessons through a paper-based booklet distributed to each student and a "trunk" of plasticized human organs and tissue grafts to observe. The stations-based flow of the present lesson plan relies on students'

observations of the specimens and the learners posing questions on paper available at each station. A USB drive contains supporting videos to run on classroom projection devices. The school-based staff supervising the students during the current face-to-face paradigm are largely substitute teachers rather than certified science educators covering the content with students as part of their science curriculum. The following sections cover the seven mindsets of design thinking supported by the creative integration of technology platforms chosen by the DACW to deliver the transplantation science curriculum in face-to-face, online, and hybrid learning environments.

3.1. Empathy mindset

Stanford and colleagues [19] assert that empathy is the root of design thinking. What is empathy? Psychologist Edward Bradford Titchener is credited with coining the term empathy from the German einfühlung—"feeling into" in 1909. Titchener pondered his kinaesthetic, sensory images that evoked feelings of gravity, pride, modesty, and courtesy to posit that the "constitutionally impartial mind does not exist" [20]. Murphy and colleagues seek to broaden our understanding of empathy that frequently takes a restrictive isomorphic matching definition of feeling in the *same* affective state as the person we observe [21]. Researchers who argue for a broader interpretation of empathy suggest that it is similar to creativity in that it unfolds in layers that cannot be reduced to a static moment [21]. The layers of empathy in the design of the transplantation science curriculum include the teacher enacting the lessons with their students, like Kevin Williams, the donors and their family members, such as Diego Videlis, and the person in need of a life-saving organ, Kate Leto.

3.1.1. Virtual avatars

The etymology of the word avatar has its roots in the Sanskrit "avatara," meaning an incarnation of a higher being. Lucasfilm's online, virtual, multiplayer game Habitat provided thousands of participants represented by avatars to meet in real-time on QuantumLink, one of the first large-scale virtual environments in the late 1980s [22]. Owners of Commodore 64 computers could meet in real-time to move their humanoid avatars controlled by the user's joystick around the Habitat virtual world to chat in speech bubbles input from the player's keyboard [23]. The unifying factor was the QuantumLink online service marketed by Lucasfilm exclusively for Commodore 64 computers [22].

Humans control avatars such as those depicted in Lucasfilm's Habitat [23] or those currently prevalent in online games such as Minecraft [24] and Roblox [25]. Pedagogical Agents (PAs) are run by *software* programmed to represent a virtual human, nurse, patient, or tutor to role-play with a human to train medical students in diagnostic scenarios or autistic students learning social skills [26]. The PA

software converses with a human using a database of questions and applicable answers maintained by software developers.

The transplantation science curriculum VAs, Kevin Williams, Diego Videlis, and Kate Leto, enact scripts developed and recorded by the education division of DACW and are not artificial intelligence PAs. The transplantation science curriculum is carefully worded to choose accurate information and authentic terminology to convey the lifesaving message of organ, eye, and tissue donation. The virtual avatars represent three groups of DACW stakeholders to facilitate the *throughput* of information to teachers, students, and their families.

The transplantation curriculum team carefully chose the race and ethnicity of the DACW virtual avatars. Kevin Williams is African American, and Diego Videlis and his family are Hispanic. One of the core values of DACW is diversity, equity, and inclusion (DEI). Representation of Black and Hispanic individuals in the curriculum intends to ameliorate the disparities found in organ, eye, and tissue donation among minority groups. The U.S. Department of Health and Human Services Office of Minority Health notes that African Americans are the largest group of minorities who need organ transplants [27]. Black individuals have higher rates of high blood pressure and diabetes, which put patients at a higher risk for organ failure [27], but Blacks receive 28.5% of all organs compared to 40.4% of white candidates [27]. Hispanic men and women have a chronic liver disease rate that is twice that of whites, and this Hispanic population is twice as likely to die from liver disease compared to whites with the same disease [28]. All transplants performed in 2020 revealed 53.8% were white, and 16.9% were Hispanic [28]. In a 2020 study that surveyed US parents with at least one child about their willingness to donate their child's organs, Black and Hispanic respondents were more likelier than white parents to believe that doctors "steal organs from patients" and "declare death based on skin color" [29]. Jones and colleagues conclude that their survey findings highlight this mistrust as a barrier that doctors must overcome to educate this population with accurate information about organ, eye, and tissue donation, procurement, and transplantation.

3.2. Radical collaboration mindset

Stanford and colleagues [19] encourage designers to involve those who traditionally might not be included in design work sessions. The radical collaboration mindset establishes connections to involve colleagues who are not involved in a project to provide a fresh perspective on the trajectory of the design. The DACW curriculum designers chose six individuals to invite feedback about the developing plan. Three colleagues are career educators, and three are DACW department managers. The designers used the Flip platform [30] to provide opportunities for their colleagues to watch an informative video about the developing curriculum and to record either a video, audio, or text reflection to share their perspectives. It was difficult to align the

schedules of diverse groups of colleagues for a synchronous feedback meeting. Therefore, the asynchronous Flip approach allowed collaborators to view the curriculum and post a reflection to fit within their busy schedules within a two-week deadline. Of the three educators, one posted a video reflection with a detailed screen recording, another educator provided an audio reflection, and the third educator wrote a detailed text response. All three DACW department managers provided text responses aligned with their diversity, equity, and inclusion mission. The Appendix (Table A.1) summarizes the feedback among the collaborators.

The common observations provided by the radical collaborators are that the variety of media in the curriculum is clear, easy to follow, entertaining to keep the students' interest, and makes aims, objectives, and goals evident. Most feedback applauded the use of an augmented reality application to allow every student to examine a projection of a realistic human organ. All collaborators appreciated the diversity of the virtual avatars to reach targeted audiences with low donor registration rates and high needs for transplants. The three educators in the collaboration group provided alignment with multicultural education, learning theory, and educational technology best practices.

3.2.1. Multicultural education connections

An associate professor (AP) of education noted that using the terms Black or African American is a personal choice for persons of color. To provide consistency, the AP suggested using the term African American when referring to science teacher Kevin Williams. In a study funded by the Rand Corporation, Steiner and colleagues conclude that all students who learn from teachers of color benefit socially and academically [31]. Introducing Kevin Williams in the transplantation science curriculum fosters inclusion and representation of teachers of color, who comprise only 20% of K-12 teachers in the United States compared to the percentage of students of color who represent over 50% of the US student population [32]. The presence of Kevin Williams in the DACW transplantation science curriculum serves both positive education and donor outcomes.

3.2.2. Neuro-education connections

A neuro-education researcher elaborated on the connections to the mind, brain, and learning science. Using the neuro-prisms framework [33], health and wellness aspects of the curriculum became salient. Students will form a sense of social wellbeing by connecting to their extended community outside the classroom. The curriculum emphasizes students' physical wellness by comparing a healthy heart using augmented reality to one that requires transplantation by examining additional interactive media. The emotional and cognitive neuro-prisms activate through empathy for the organ recipient and use accurate information to dispel misconceptions and fears. The neuro-researcher noted that the mind-brain

connections foster lifestyle changes through registration as an organ donor. Spiritual connections in the neuro-prisms framework evoke a sense of awe about the human body and organ, eye, and tissue donation as an act that extends beyond the "self" for the greater good of humanity.

3.2.3. Educational technology best practices

A chief architect (CA) of an educational technology organization reviewed the curriculum through delivery, accessibility, and presentation lenses. The CA suggested a curriculum deployment software that fosters responsive formats for mobile, tablet, laptop, and desktop devices. Responsive refers to an internet software platform's ability to detect a user's device "real estate" and adjust the content to be readable on their mobile, tablet, laptop, or computer device. Internet platforms that do not adjust to a user's device still exist, making the content unreadable or requiring a user to pinch and pull the screen to see the content. The transplantation science curriculum EdTech platforms are "responsive" to correctly display the content on the curriculum team's devices. Another iteration of responsiveness testing will occur when the team adds a school partner to provide curriculum feedback in the upcoming stages of the design.

To honor the intended "throughput" of the transplantation science curriculum among teachers, students, and their families, it is crucial to focus on mobile learning (m-Learning) because students view education content on their mobile, tablet, laptop, and desktop computer devices. As noted by Parlakkilic, the success of EdTech initiatives hinges on the proper display of m-Learning content through responsive design [34].

3.2.4. DACW managers connection

The three DACW manager collaborators contributed feedback through the company mission and vision lens. They valued the throughput of the curriculum from teacher to student to family community. They were enthused by the updates of the transplantation science curriculum from largely paper-based and physical model paradigms to an online curriculum with a variety of engaging media and interactive activities. Their suggestions about expanding the curriculum to other organs and diverse groups led to the next "Yes…And" design thinking mindset.

3.3. The "Yes…And" mindset

Fans of improvisational theater witness actors' "Yes…And" methods that support taking what a collaborator just shared to create a sense of trust that their idea is valued and worthy of being built upon by their partners [35]. The Level A Improv classes at The Second City improvisational comedy group introduce this constructive mindset to students of acting that transfer quickly to school and business environments. It is easy to deflate an idea by saying "no." Instead, the chain

of ideas grows by saying "Yes…And" to value and build upon the previous viewpoint. The transplantation science team received positive feedback about the developing curriculum content that provided "Yes…And" opportunities. For instance, a DACW human resources (HR) generalist valued "yes," the diverse depiction of male African-American, male Hispanic, and white female avatars, "and" suggested the team add inclusive religious depictions such as a woman in a hijab. A DACW manager for staff development agreed, "yes," with the coverage of heart transplants as the organ to introduce the transplant science curriculum, "and" suggested that the team covers kidney transplants next since this is an organ that has the greatest need.

3.4. Thinking by doing mindset

The "thinking by doing" mindset invites us to stop talking and make something [19]. Teams can pause to create a tangible representation of ideas through online tools such as Loom videos [36] and Mural Board [37] collaborative workspaces. The beauty of applications such as Loom and Mural Board is the asynchronous collaboration opportunities. The transplantation science curriculum team members live in different states in the western and eastern regions of the US. The competing demands of family, work, and self-care makes it challenging to schedule synchronous meetings to move the ball down the field of curriculum design. By recording a Loom video about how to edit a Mural Board collaborative workspace, team leaders offer members a chance to watch an instructional video based on their busy schedule and enact the steps to contribute to the next phase of the design process to "think" and "do" in an asynchronous, Mural board, tangible workspace.

3.5. Iteration mindset

Iteration mindset is one that embraces a non-linear approach to foster curriculum design. One can view the transplantation science curriculum as a multifaceted problem that designers must break into a collection of smaller problems. This iterative mindset aligns well with computational thinking, a concept originally coined by Seymour Papert in 1980 in his seminal book *Mindstorms* to foster the LOGO programming language environment that controlled the Turtle, the first application of educational robots [Mindstorms]. Papert mused that a student programs the computer by teaching it how to think and, in turn, "embarks on an exploration about how they themselves think" [38, p. 3]. In 2006, Wing expanded upon Papert's mindset to assert that computational thinking is a fundamental skill everyone must know to thrive in the modern era [39].

Carnegie Mellon University colleagues Cross, Hamner, Zito, and Nourbakhsk created a framework designed to foster students' computation thinking skills. Figure 1 reveals the three categories of computational thinking and the component skills of each category developed by Cross and colleagues to foster widespread applications of computational thinking in education settings [40].

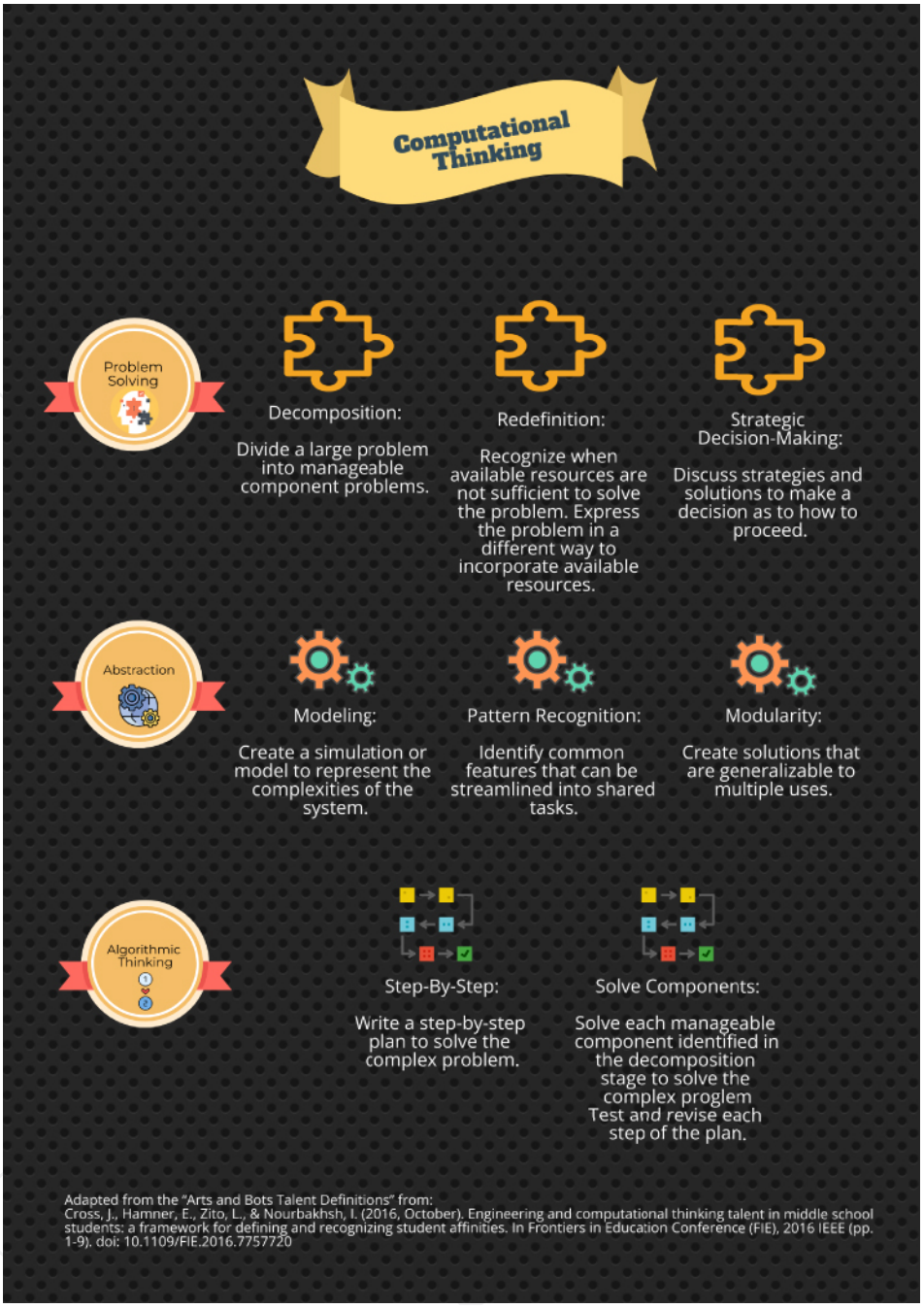

Figure 1. Computational thinking skills and components.

3.5.1. Computational thinking—problem solving through decomposition

The curriculum design team decomposed the larger problem of transplantation science into component problems to authentically depict the aggregate stakeholders and complexities of the organ, eye, and tissue donation process. The team accomplished the decomposition step through synchronous Zoom sessions and asynchronous brainstorming using the Mural board [37] platform and Loom [36]

videos to record and share ideas. Additionally, the radical collaborators discussed in section 3.2 enriched the decomposition to consider multiple perspectives.

3.5.2. Computational thinking—problem solving through redefinition

The organ, eye, and tissue donation stakeholders are humans protected by health regulations safeguarding their privacy. The curriculum design team redefined the stakeholders by using VAs to represent plausible donation and procurement circumstances since the team could not divulge identifiable individuals.

3.5.3. Computational thinking—problem solving—strategic decision-making

DACW strategically decided to eliminate negative wording typically used by the media or fictional depictions of organ, eye, and tissue donation. Instead, the team carefully selected terminology to foster the life-saving organ donation, procurement, and transplantation process. The first deliverable of the curriculum includes the introduction of VAs, managing misconceptions, and a multimedia introduction to the heart, including the allocation process to select an organ recipient. The nascent curriculum received feedback from a high school science teacher in the Denver, Colorado region to inform the throughput of teacher-to-student and their families. The feedback from a potential curriculum partner, school setting, and the district is an important step to discovering the methods to share the lesson plans to achieve the intended throughput of the curriculum from teachers to students and their families.

3.5.4. Computational thinking—abstraction through modeling

The abstraction component of computational thinking begins with developing a model to represent the system's complexities. Using the technological, pedagogical, and content knowledge framework (TPACK) developed by colleagues Koehler, Mishra, and Cain [41], the curriculum team contemplated enacting the transplantation science curriculum in heterogeneous school settings. Every teacher, classroom, school, and district has a variety of affordances at their disposal. The term affordance refers to the relationship between a person and their environment that contains opportunities to take action within their reach [42]. Effectivities are a person's capacity for transforming their affordances into actions [42]. Using the TPACK framework, the transplantation science team created a model to depict the successful implementation of the curriculum by the teacher, their students, and throughput to families. The hardware and software affordances within a teacher's reach differ from school to school. According to the Pew Research Center, 97% of adult Americans own a cell phone, and of those phones, 85% are smartphones capable of web browsing and running applications [43]. It is important to know the prevalence of smartphones to predict the throughput of the curriculum to teachers' and students' families and the community at large. The minimum affordances to enact the transplantation science curriculum require:

- access to WiFi and the WiFi password
  - not all locations in a school have adequate bandwidth due to the proximity of WiFi hotspots to the classroom space.
- Access to tablets or mobile devices, sometimes requiring a reservation of a shared school "cart" of charged devices for AR content.
- The administrative password for the tablets or mobile devices to download applications
  - if a technical support group manages the devices, the team must provide adequate time to download and install the apps.
- A classroom projector or TV to display video content
  - in the absence of a classroom projector, students can view the videos on laptops or smartphones, preferably with earbuds.
- Access to a printer and copier to provide a merge cube for each student or group.

With the minimum WiFi, hardware, and software in place, the team can forecast a model of the knowledge needed by the teacher to enact the curriculum. Figure 2 depicts the TPACK framework highlighting the three main areas of teachers' knowledge. The main areas are technical knowledge (TK), content knowledge (CK), and pedagogical knowledge (PK).

3.5.4.1. The intersection of technical knowledge with content knowledge (TCK). The transplantation science curriculum contains a variety of interactive media to depict each organ, beginning with a study of the heart. The teacher now has effectivities, the set of capacities for action, to enact the transplantation science curriculum in the classroom. The intersection of technological knowledge of hardware and software provides the platforms to deliver the transplantation science content. DACW shares the curriculum with certified science teachers to enact the lessons in alignment with the Colorado and Wyoming middle and high school life science state standards [Colorado DOE, Wyoming DOE].

3.5.4.2. The intersection of pedagogical knowledge with content knowledge (PCK). The Colorado and Wyoming certified science teachers align the DACW transplantation science curriculum with their pedagogical methods and practices in their life sciences instruction according to their state standards [44, 45]. Pedagogy in the transplantation science curriculum fundamentally refers to the interactions between educators and learners in classrooms and the community at large. In 2011, Joan Wink wrote about critical pedagogy, which thinks deeply below the surface of a topic to reflect upon our own experiences and that of others [46]. Critical pedagogy is transformative teaching and learning which embraces the imperative that we,

Figure 2. Technological, pedagogical and content knowledge (TPACK) framework.

in education, mirror society [46]. Through the lens of critical pedagogy, DACW enacts a reflective cycle to focus on transplantation science and ultimately develop an action plan to transform this lifesaving curriculum.

3.5.4.3. The intersection of technological and pedagogical knowledge (TPK).
The throughput to families in the school community is essential to the DACW transplantation science curriculum. Using platforms such as Adobe Captivate [47]

or Articulate 360 [48], DACW can share a private link to the curriculum with the teacher, the students, and their families. The team can share additional instructional videos as a preamble to describe the scope and sequence of the resources for the benefit of those viewing the curriculum outside of the classroom. Ultimately, DACW can share the link to the curriculum at community centers and libraries to widen the dissemination of transplantation science.

3.5.4.4. Three intersecting circles—technological, pedagogical, and content knowledge. By addressing the intersections of technological, pedagogical, and content knowledge, DACW can discover the needed support at each school, community center, or library setting to implement the transplantation science curriculum successfully. Each setting might have an area(s) of weakness. The TPACK framework serves as a model for each new setting.

3.5.5. Computational thinking—abstraction through pattern recognition and modularity

As the curriculum team developed the transplantation science lessons, they began to see patterns of topics that reach all organ, eye, and tissue donations. For instance, height, weight, age, geographic location, state of health, and urgency of need are common considerations for organ allocation. The lessons about different organs can share the resources and matching activities about eligibility requirements to determine the best match from the donor to the recipient. Therefore, the curriculum created infographic modules to place in multiple organ lessons.

3.5.6. Computational thinking—algorithmic thinking through a step-by-step plan

Knowing the transplantation science curriculum's common modules informs the lessons' scope and sequence. The following list reveals an overview of the step-by-step plan to develop lessons.

- Overview of transplantation science
- The Heart
- Heart Allocation
- The Kidney
  - Middle School lessons
  - High School lessons with advanced topics about the kidney
- The Human Body Tissues
- The Eye
- The Donation Process

3.5.7. Computational thinking—algorithmic thinking and solving component problems

Solving the component problems of the transplantation science curriculum involves fine-tuning each lesson with supporting common modules. The lessons' aggregate

forms the curriculum ready to deliver to the middle and high school science teachers to test the prototype within the classroom. Design thinking is an interactive, ongoing process subject to modifications based on teachers' and students' feedback. The dissemination of the curriculum began with a strategic selection of one middle school and one high school science teacher. DACW developed a questionnaire to confirm teachers' access to the minimum hardware and software needed to implement the transplantation science curriculum and sent it to the teachers to verify their classroom affordances. After confirming the minimum configuration, the curriculum team shared the link to the curriculum with educators who will enact the overview, heart, and heart allocation lesson plans. The share of the curriculum with educators bridges their affordances to new effectivities.

3.6. Go broad to go narrow mindset

One can discover solutions that are not necessarily obvious by casting a wider net to examine groups that will benefit from the transplantation science curriculum. Broadly speaking, DACW serves the residents of Colorado and Wyoming. Residents can gather at many DACW public events, community centers, libraries, parent-teacher organizations, high schools, and middle schools. The narrow focus of classrooms could expand to other resident gatherings using the same link to the curriculum viewed on mobile devices across the two states served by DACW.

3.7. Embrace ambiguity mindset

Embracing ambiguity in organ, tissue, and eye procurement, donation, and transplantation is a condition already prevalent in the work of the Donor Alliance of Colorado and Wyoming. The transplantation science curriculum is DACW's attempt to break the tsunami of misinformation prevalent in the media. The overarching goal of this project is to deliver accurate content to students, their families, and the education community about how donations and transplants work and who this life-saving science impacts.

4. Conclusion

Donor Alliance of Colorado and Wyoming revitalized their transplantation science curriculum by infusing creative technology into lesson planning and methodologies. By examining the affordances in educators' environments, DACW streamlined the delivery of an engaging and interactive transplantation science curriculum to foster accurate terminology grounded in empathy toward organ, eye, and tissue donors, their families, and the grateful recipients. The curriculum team constructed a bridge from educators' affordances to their effectivities to provide them with virtual avatars, surveys to reveal current knowledge, audio, and video content to invite

questions, and interactive augmented reality applications to delve deeply into the study of the human body.

In the spirit of design thinking, the curriculum team will continue to evaluate the success of the revitalized transplantation science curriculum using a post-implementation survey of the accurate transplantation science knowledge gained by educators, students, and their families.

The present article does not represent a scientific study. Future research of the Donor Alliance of Colorado and Wyoming could include a pre- and post-curriculum survey of stakeholders' perceptions about organ, tissue, and eye procurement, donation, and transplantation. This article describes revamping a paper-based curriculum to one that uses modern methods to enhance teaching and learning.

Conflict of interest

The author declares no conflict of interest.

Acknowledgments

The author gratefully acknowledges the collaboration of the Donor Alliance of Colorado and Wyoming to revitalize their transplantation science curriculum. The support and teamwork of Cheryl Talley, Director of PR/Communications, and Devyn Halsted, Public Education Coordinator, are especially appreciated.

Appendix

Table A.1. Radical collaboration feedback.

Collaborator	Feedback format	Insights
Associate professor	Audio	• Curriculum is well-paced • Variety of media is easy to follow and entertaining to keep the interest of the students • Likes the augmented reality component of the curriculum • Appreciates the diversity of the virtual avatars • Suggests using the consistent term African American for Kevin Williams • Notes that using Black or African American is a personal choice to persons of color • Radical collaborator learned something about organ, tissue, and eye donation from the radical collaboration video

Table A.1. (Continued)

Collaborator	Feedback format	Insights
Neuro-education researcher	Video	• The curriculum has clear description of the aims, objectives, and goals • Appreciates the life-saving impact, salience, and meaning-making of the curriculum • Emphasized the socioethical and empathy building components of the curriculum • The description of the problem is clear to recognize the prevalence of misinformation • The mention of the throughput of the curriculum from teachers to students to parents is valuable • Appreciated being asked to be a radical collaborator • Variety of media is easy to follow and entertaining to keep the interest of the students • Values the alignment of asking for feedback with Lewis' [49] improvement science aligned with plan-do-study-act (PDSA) • Appreciates asking what students know first to make curriculum student-centered • Appreciates the diversity of the virtual avatars • Likes the augmented reality component of the curriculum • The curriculum is timely to align with the Grammy awards—Bonnie Raiit's 2023 song of the year "Just Like That" about a son's heart organ donation [50]. • Neuro-education prism [33]—Health and Wellness connections to curriculum: ° Social well-being—connections with the community ° Physical anatomy—the augmented reality component activates the students' connections to the human body as they examine the heart ° Emotional and cognitive—activates *empathy* for organ recipient and learning accurate information ° Lifestyle—registration as an organ donor ° Spiritual—a sense of awe about the human body. An act that is more than self. • Neuro-education prism [33]—intrinsic motivation ° Competence and usefulness—teachers and students work with multi-media to learn about organ, eye, and tissue donation

Table A.1. (Continued)

Collaborator	Feedback format	Insights
		° Tension reversed—donation is aligned with *authentic terminology* to demystify the process of organ, eye, and tissue donation ° Relatedness—the curriculum brings together diverse populations ° Choice—multiple means of engagement of the curriculum media ° Enjoyment—the curriculum takes a delicate topic to make it an authentic learning experience enjoyable.
Chief architect—EdTech Organization	Text	• The curriculum has a clear description of the aims, objectives, and goals • Appreciates the diversity of the virtual avatars—"refreshing" • Likes the augmented reality component of the curriculum • Suggests offering printed copies of the merge cube to students working from home who do not have a printer • Suggests looking into additional artificial intelligence (AI) platforms to develop hyper-realistic avatars • Suggests curriculum deployment software such as Adobe Captivate [47], Articulate 360 [48] to foster non-linear presentation of media
DACW manager—staff development	Text	• Variety of media is easy to follow and entertaining to keep the interest of the students • Appreciates the diversity, equity, and inclusion of the virtual avatars to reach targeted audiences that have low registration rates and high needs for transplants • Suggests adding more information about lung, liver, pancreas, and kidneys that have the greatest need • Variety of media is easy to follow and entertaining to keep the interest of the students to connect with tech-savvy youth
DACW manager—donor services	Text	• Appreciates the diversity, equity, and inclusion of the virtual avatars to reach targeted audiences that have low registration rates and high needs for transplants

Table A.1. (Continued)

Collaborator	Feedback format	Insights
DACW technology coordinator	Text	• The mention of the throughput of the curriculum from teachers to students to parents is valuable • Likes the augmented reality component of the curriculum • Believes that the videos pertaining to how the heart works supports students interested in healthcare careers • Variety of media is easy to follow and entertaining to keep the interest of the students • Appreciates asking what students know first to make curriculum student-centered
DACW human resources	Text	• Consider depicting other avatars to incllude religious affiliations such as a woman in a hijab

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